ORION™ 2.4 HX

Non-Linear Junction Detector

User Manual

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www.reiusa.net

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ORION™ 2.4 HX

Non-Linear Junction Detector

The ORION 2.4 HX is available in two different models: ORION 2.4 HX 6.6W and ORION 2.4 HX 3.3W. The ORION 2.4 HX 6.6W has a transmit power level of 6.6 Watts EIRP. It is authorized for use only by agencies, persons, and entities not restricted by US Federal Communications Commission (FCC) and Industry Canada (IC). It is not CE Marked. The ORION 2.4 HX 3.3W has a transmit power level of 3.3 Watts EIRP. It is compliant with FCC and IC technical standards and has been CE marked.

This document is intended to provide guidance and instruction on using the ORION 2.4 HX Non-Linear Junction Detector for finding hidden electronic devices.

This manual contains proprietary information intended solely for use with the ORION 2.4 HX Non-Linear Junction Detector.

The overall effectiveness of this product, and of any surveillance countermeasure, is dependent on the threat level and the user's ability to properly utilize the appropriate equipment. The REI Training Center offers training on technical surveillance countermeasure equipment.

Revision 2.1

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REI products are designed and intended for legal commercial applications, however because laws and regulations vary from state to state and country to country, it is the sole responsibility of the purchaser and user/operator to check and comply with all applicable laws and regulations for the possession and operation of this equipment before and after making a purchase.

WARNING: It is the responsibility of the user to comply with the appropriate radio communication laws of the country in which the ORION 2.4 HX is being used.

The ORION 2.4 HX 3.3W complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The ORION 2.4 HX 3.3W complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le ORION 2.4 HX 3.3W se conforme à Industrie Canada exempts de licence (s) standard RSS. Son utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter Toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

The ORION 2.4 HX 6.6W is authorized for use only by agencies, persons, and entities not restricted by US Federal Communications Commission (FCC) or Industry Canada.

Information contained in this manual including product operation and specifications is subject to change without notice.

Any product or brand names contained in this manual are used only for identification purposes and are trademarks or registered trademarks of their respective holders.

Patents Pending

OWNER'S RECORD
The Serial Number of each ORION 2.4 HX is located on the bottom of the unit near the battery compartment door. Please record this number and refer to it whenever you contact your dealer or Research Electronics International concerning this product. Note: Removal or alteration of the serial number automatically voids all warranties of this product.

SERIAL NUMBER: _____

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The ORION 2.4 HX 3.3W model has been tested and complies with the essential requirements of the following CE directives:

LVD Directive 2006/95/EC

EMC (Electromagnetic Compatibility) Directive 2004/108/EC

However, additional restrictions may need to be observed depending on where this product is used. Please consult the table below for a list of required restrictions by country. To operate the equipment legally, it must be operated within these restrictions for the given country. See Page 29 for details on how to configure the ORION 2.4 HX 3.3W to operate within these restrictions.

NOTE: The model ORION 2.4 HX 6.6W is not CE Marked and the Country menu is not accessible for this model.

Country	Restrictions	"Country" setting for ORION 2.4 (see Page 29)
Austria (AT)	100 mW Max Transmit Power	Austria
Belgium (BE)	No restrictions	FCC/IC/CE
Bulgaria (BG)	2.446 GHz to 2.454 GHz Transmit Freq Range	Bulgaria
Cyprus (CY)	No restrictions	FCC/IC/CE
Czech Republic (CZ)	No restrictions	FCC/IC/CE
Denmark (DK)	No restrictions	FCC/IC/CE
Estonia (EE)	No restrictions	FCC/IC/CE
Finland (FI)	No restrictions	FCC/IC/CE
France (FR)	10 mW Max Transmit Power	France
Germany (DE)	25 mW Max Transmit Power	Germany
Greece (GR)	No restrictions	FCC/IC/CE
Hungary (HU)	10 mW Max Transmit Power	Hungary
Iceland (IS)	No restrictions	FCC/IC/CE
Ireland (IE)	No restrictions	FCC/IC/CE
Italy (IT)	10 mW Max Transmit Power	Italy
Japan	10 mW Max Transmit Power	Japan
Latvia (LV)	No restrictions	FCC/IC/CE
Liechtenstein (LI)	10 mW Max Transmit Power	Liechtenstein
Lithuania (LT)	10 mW Max Transmit Power	Lithuania
Luxembourg (LU)	No restrictions	FCC/IC/CE
Malta (MT)	No restrictions	FCC/IC/CE
Netherlands (NL)	No restrictions	FCC/IC/CE
Norway (NO)	No restrictions	FCC/IC/CE
Poland (PL)	No restrictions	FCC/IC/CE
Portugal (PT)	10 mW Max Transmit Power	Portugal
Romania (RO)	No restrictions	FCC/IC/CE
Slovak Republic (SK)	No restrictions	FCC/IC/CE
Slovenia (SI)	10 mW Max Transmit Power	Slovenia
Spain (ES)	No restrictions	FCC/IC/CE
Sweden (SE)	No restrictions	FCC/IC/CE
Switzerland (CH)	10 mW Max Transmit Power	Switzerland
United Kingdom (UK)	No restrictions	FCC/IC/CE

* Note: The operator violates German law if the unit is operated with a higher power than permitted. Fine regulation of TKG §148 and §149 could apply. Units shipped into Germany will be preset with the German Country setting.

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Technical Security Training

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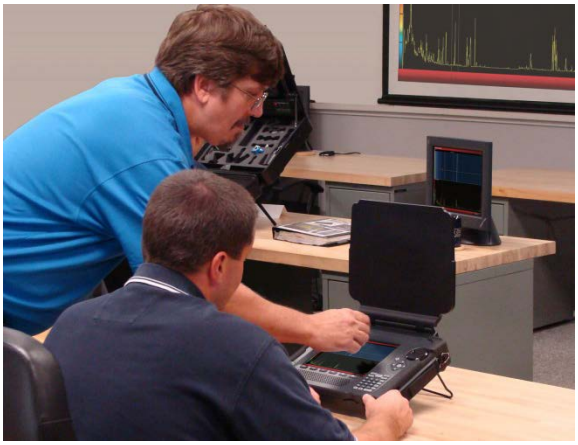
Regularly scheduled courses are taught monthly; visit REI's website (www.reiusa.net) or contact REI (sales@reiusa.net) for training dates.



Contact REI for more information about technical security training and/or other equipment: www.reiusa.net

PRECAUTIONS

ORION 2.4 HX

- CAUTION: Any changes or modifications not expressly approved by REI could void the user's authority to operate the equipment.
- The ORION 2.4 HX is for professional use only.
- The ORION 2.4 HX is capable of emitting a radio signal between 2.404 GHz and 2.472 GHz. It is the responsibility of the user to practice good safety procedures. In doing so, you should take the following precautions:
    - Do not point the antenna at a person's eyes or head.
    - Maintain a distance of at least 28 cm between the antenna and the body of the user or nearby persons
    - Do not leave the antenna in close proximity to any part of the body for more than 5 minutes.
    - Do not use near flammable fluids or explosives or in any area where the use of radio communications equipment is prohibited.
    - Do not use in close proximity to any person fitted with a heart pacemaker, heart defibrillator, or any other life support device.
- For your own safety do not use the ORION if:
    - The ORION cables or its plugs become frayed or otherwise damaged.
    - The ORION housing is cracked or otherwise damaged.
    - You suspect that the unit requires servicing
- Only use REI approved power sources, batteries, chargers, and accessories. The supplied power supply is REI #UIB345-15. The supplied battery pack is RRC Power Solutions Lithium Ion Rechargeable Battery pack Model #RRC2040, rated 11.25V, 2950mAh, 33.2Wh or Inspired Energy Lithium Ion Rechargeable Battery pack Model #NC2040HD, rated 10.8V, 2.9Ah, 31Wh. The supplied real-time clock battery is a CR2032 coin cell battery with the following specifications: 3V nominal voltage, 225mAh nominal capacity, -30°C to 60°C operating temp
- The ORION should not be used for normal operation while charging a battery in the device. To return to normal operation, disconnect the AC power supply.
- There are no serviceable parts inside. Contact your dealer or Research Electronics International, LLC for repairs. Opening the unit will void the warranty.
- For your own safety do not use the AC power battery charger if:
    - The battery charger cables or its plugs become frayed or otherwise damaged.
    - The battery charger housing is cracked or otherwise damaged.
    - The battery charger is exposed to rain, liquid or excessive moisture.

Lithium-Ion Batteries

- CAUTION: RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.
- For your own safety do not use any ORION battery if:
    - The battery case is cracked or otherwise damaged.
    - The battery is excessively hot or warm for any reason.
- Avoid shorting the battery, immersing in water, or exposing to fire. Also, avoid excessive physical shock or vibration.
- Only use the specified REI battery chargers or products to charge REI batteries
- There are no serviceable parts inside the battery. Contact your dealer or Research Electronics International, LLC for repairs. Opening or puncturing the unit can be dangerous and may result in injury.
- Using the Lithium-Ion batteries in a manner not specified by this user's guide may override the equipment's built-in protection mechanisms.
- Keep out of the reach of children.
- Dispose of Lithium-Ion batteries in accordance with local regulations.

Equipment Description

Overview

1. **ANTENNA** – located on opposite side of head display
2. **HEAD DISPLAY** – LED Bar graphs for indicating Transmit Power level, 2nd & 3rd Harmonic levels and a small OLED informational display for indicating status and displaying the menu.
3. **TOUCHSCREEN DISPLAY** – used for controlling the ORION 2.4 HX and monitoring its operation
4. **HEADPHONE JACK** – for connection of headphones to monitor audio from the unit
5. **USB CONNECTOR** – used for connecting to a PC for software updates
6. **MICRO SD CARD** - used for saving screen shots or user settings
7. **POWER BUTTON** - Press to power on. Press and hold while the unit is on to power off.
8. **SPEAKER** – used to monitor audio from the unit
9. **POWER INPUT** *(under battery door)* – for connecting AC adapter for charging (only use REI supplied AC Adapter)
10. **BATTERY DOOR / BATTERY DOOR LATCH** – conceals battery compartment

Ports

1. **USB Connector** – used for connecting to a PC for software updates
2. **MICRO SD CARD Slot** - used for saving screen shots or user settings

SET-UP & BASIC OPERATION

The ORION 2.4 HX has been designed for quick and easy deployment. Depending on your application, some adjustments to the default setting may need to be made.

Battery Usage

Lithium-Ion rechargeable batteries have been included with your unit.

To insert or switch out a new battery:

1. While pressing the latch on the bottom of the grip housing unit, raise the battery door at the rear of the unit.
2. Slide the battery into the battery slot observing proper contact alignment until it latches into place.
3. Close the battery door.

The ORION 2.4 HX has a built-in battery charger. To charge the battery in the unit:

1. While pressing the latch on the bottom of the grip housing unit, raise the battery door at the rear of the unit.
2. With the battery already inserted in the unit, connect the provided AC power supply to the jack located just above the battery slot and to an AC source. The battery will begin charging. Charging is automatic; it will stop when the battery is fully charged. The OLED display on the head indicates the battery charge status during charging.

Note: The device should not be used for normal operation while charging a battery in the ORION unit. To return to normal operation, disconnect the AC power supply.

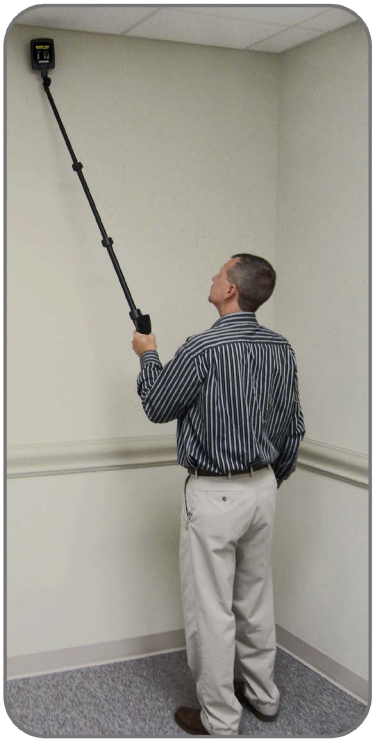
Note: To keep the battery in good working condition, it should be removed from the device for long term storage of 90 days or more. Even when powered off, the operating system of the ORION unit continues to use a low stand-by current that in some cases could cause a deep discharge and possible damage to the battery, preventing a normal recharge.

Real Time Clock Battery

An internal CR2032 coin cell battery provides power for the real time clock function and for maintaining saved user settings. The Real Time Clock (RTC) battery should provide years of service. In the event that the clock on the ORION unit stops functioning or user settings are no longer saved, the Real Time Clock battery will need to be replaced.

To replace the Real Time Clock battery:

1) Open the battery door and remove the product's Lithium Ion Battery.
2) Remove the Phillips head screw in the panel above the battery compartment.
3) Slide the battery tray that rests above the battery compartment out of the unit. Do not disconnect the cable attached to the circuit board.
4) Locate the CR2032 battery on the right side of the battery tray circuit board.
5) Remove the old CR2032 battery from the battery clip and replace with a new CR2032 battery. Observe the battery polarity marking on the holder clip when replacing the battery; the positive (+) side should be facing up, away from the circuit board.
6) Replace the battery tray and secure with the Phillips head screw. Be careful not to pinch the attached cable while positioning the battery tray. Do not force the battery tray – the tray rests along plastic ridges in the side of the battery compartment. If positioned correctly, it should slide easily into place.

Note: The provided internal coin cell is a CR2032 battery with the following specifications: 3V nominal voltage, 225 mAh nominal capacity, -30°C to 60°C operating temperature.

After taking the product out of the case, follow these simple steps to begin using it:

1. Place one of the provided rechargeable batteries in the battery compartment
2. Rotate the head for easy viewing
3. If preferred, extend the telescoping pole to a convenient length

Procedure

When the device is turned on, it scans the Transmit, 2nd Harmonic, and 3rd Harmonic spectrums and automatically selects a quiet frequency avoiding any interference. The operator may also manually select frequencies. Two test tags are included with the device. One is a semiconductor diode to simulate an electronic device. The second is a steel wool pack, to simulate a corrosive metal-to-metal junction. These tags can be used to verify the proper operation of the ORION unit.

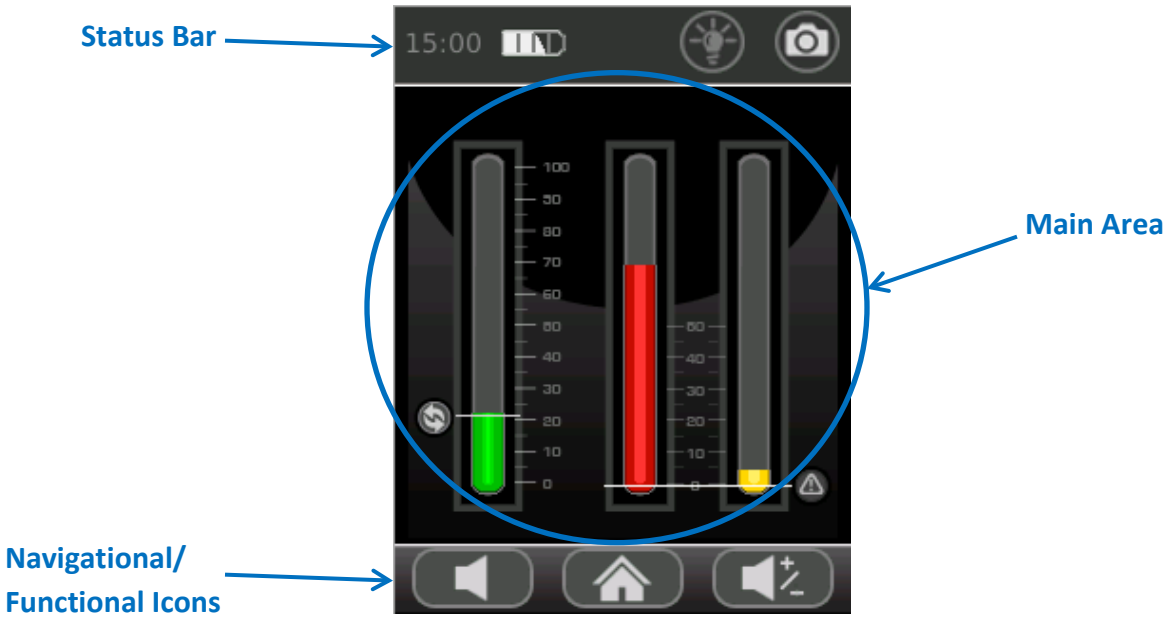
There are two basic procedures to using any Non-Linear Junction Detector:

1. Detecting a non-linear junction and
2. Discriminating between electronics and false detection

The ORION 2.4 HX can be configured multiple ways to aid in these two processes.

Display Screens

Display Screen Layout



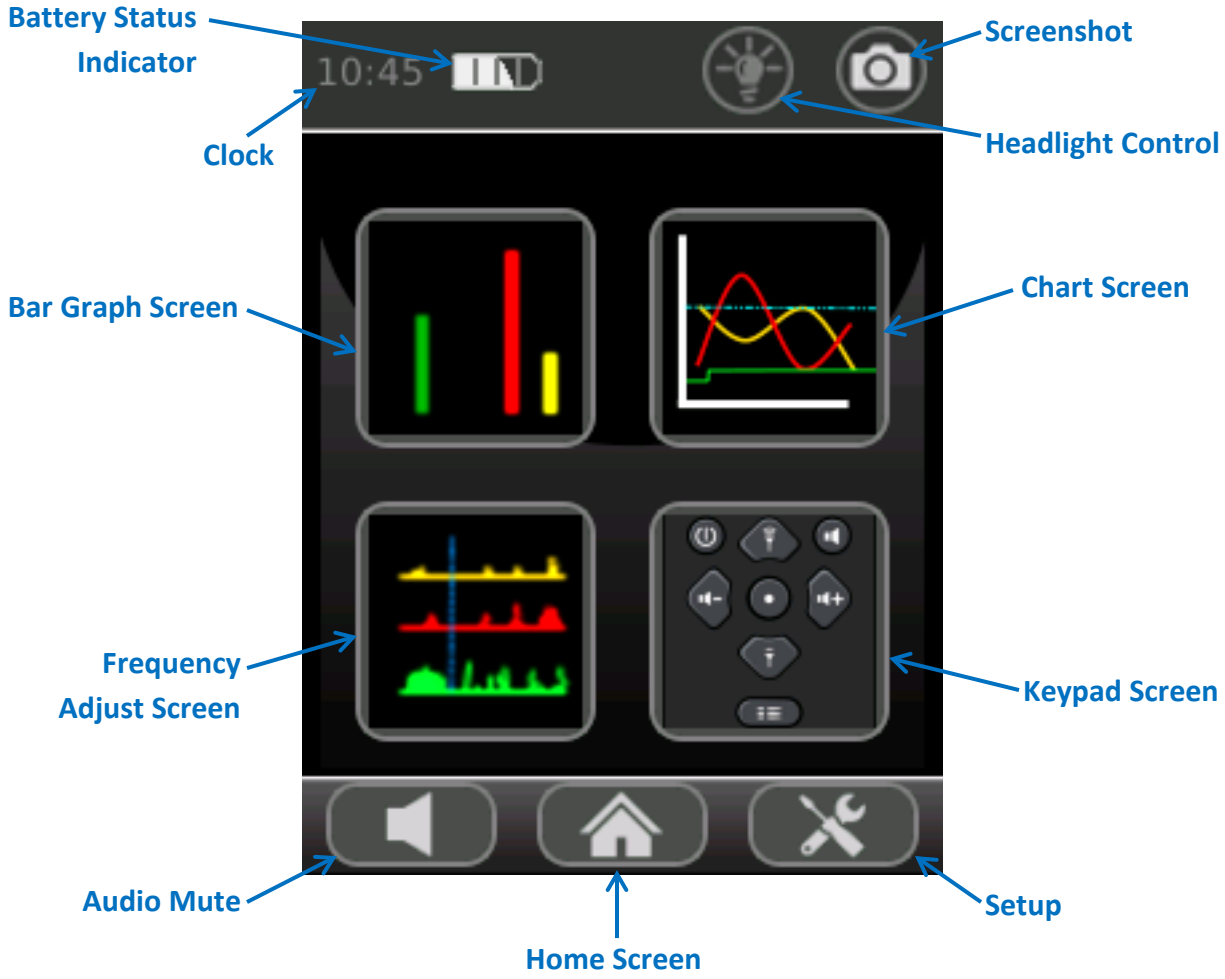
Status Bar - This area of each screen contains status icons indicating the current condition of the ORION unit. Tapping the camera icon in the status bar will take a screenshot and save it to a micro SD card.

Main Area - The content of this area will vary depending on which screen is currently selected.

Navigational/Function Icons - The icons in this area also vary depending on which screen is currently selected. They will typically aid with navigating to another screen or will provide quick access to typically used functions.

Home Screen

By default, the Home Screen is the initial screen shown after the ORION unit is powered on. The Home Screen allows for quick navigation to any of the main operational modes. The diagram below details what functions are accessible when the various icons are tapped on the screen.



Battery Status Indicator - indicates the charging level of the battery. This indicator is common to all of the display screens.

Screenshot - Tapping this icon will capture a screenshot of the current display and save it to the inserted microSD card. For additional details regarding the screenshot feature, see page 31.

Clock - This indicator displays the current time. This indicator is common to all of the display screens. For instructions on setting the clock, see page 28.

Headlight Control - Tapping this icon will toggle the headlamp off and on.

Bar Graph Screen - Tapping this icon will take the user to the Bar Graph Screen (see page 17).

Chart Screen - Tapping this icon will take the user to the Chart Screen (see page 19).

Frequency Adjust Screen - Tapping this icon will take the user to the Frequency Adjust Screen (see page 20).

Keypad Screen - Tapping this icon will take the user to the Keypad Screen. The keypad screen gives the user an alternate method for controlling the ORION 2.4 HX operation.

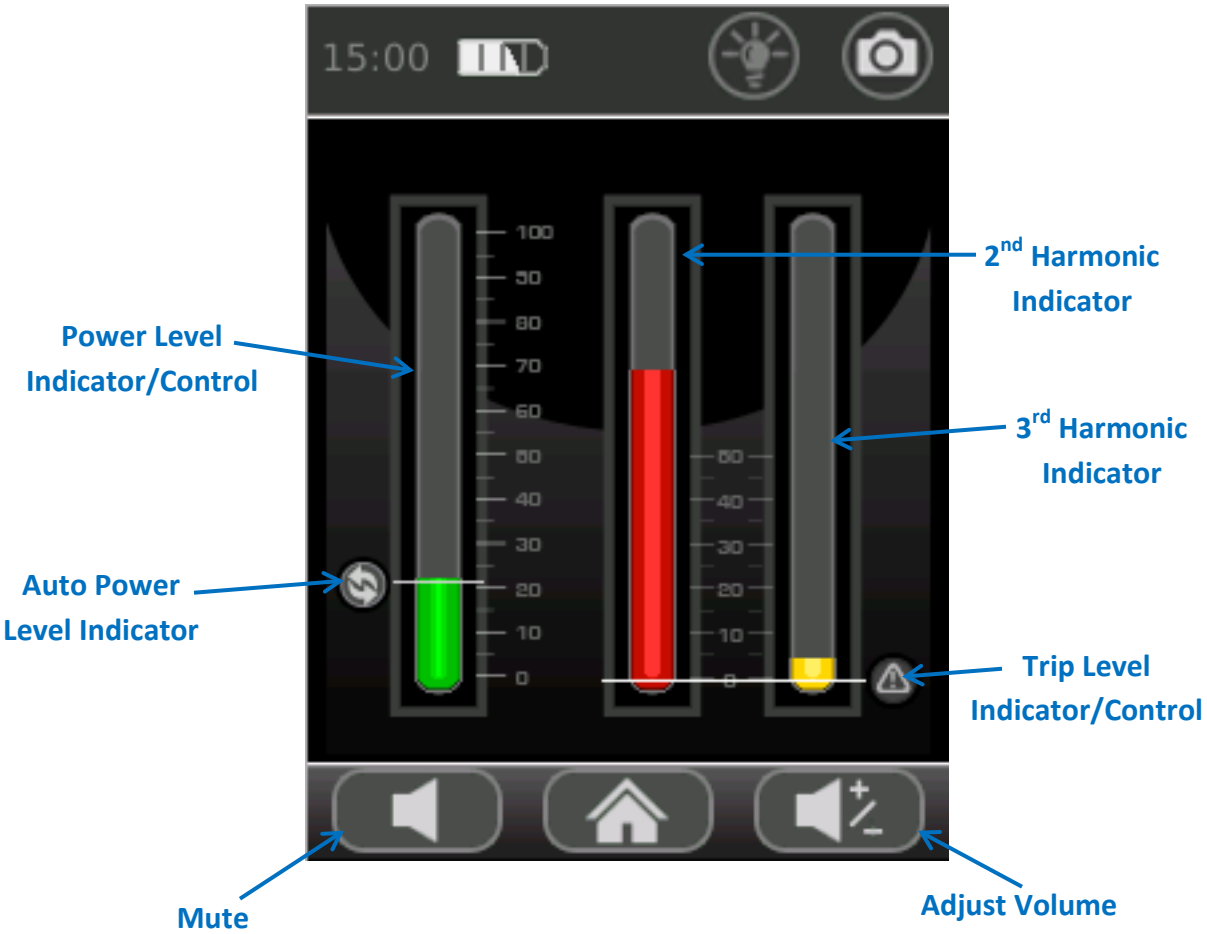
Audio Mute - Tapping this icon will mute the audio. Tapping this icon a second time will unmute the audio.

Home Screen - This icon is common to all of the display screens. It returns the user to the Home Screen. When the user is already on the Home Screen, this button has no function.

Setup - Tapping this icon will access the device

Bar Graph Screen

The bar graph screen replicates the indicators that are found on the head of the device.



Power Level Indicator/Control - To increase the transmit power level, tap on the top half of the Power Level Indicator. The green bar graph will increase corresponding to the increase in transmit power. To decrease the transmit power level, tap on the bottom half of the Power Level Indicator. The green bar graph will decrease corresponding to the decrease in transmit power.

Auto Power Level Indicator - The Auto Power Level Indicator is shown on the Bar Graph Screen, whenever the device is operated in auto transmit mode. The device can be operated in either auto transmit mode or manual transmit mode. In auto transmit mode, the transmit power will automatically reduce whenever the receiver becomes saturated. In manual transmit mode, the transmit power remains at the same level unless it is manually changed. The Auto Power Level Indicator indicates the set maximum transmit power level. If the receiver becomes saturated, for example, due to a target, the actual power level, indicated by the green bar, will decrease, but the Auto Power Level Indicator will stay at the same level to indicate the max power level. If the unit is in auto transmit mode, adjusting the transmit power level will also adjust the auto power level. To toggle between auto and manual transmit modes, quickly press the power button.

2nd Harmonic Indicator - The 2nd & 3rd harmonic indicators help to discriminate between electronic devices and false junctions. For electronic devices, the 2nd harmonic level will be higher than the 3rd harmonic level.

3rd Harmonic Indicator - The 2nd & 3rd harmonic indicators help to discriminate between electronic devices and false junctions. For false junctions, the 3rd harmonic level will be higher than the 2nd harmonic level. For additional information regarding the theory behind the ORION's operation, see the Appendix (page 34).

Trip Level Indicator/Control - To set a trip level for the alert tone, the vibration feedback, and target indicators ("SEMICOND" or "CORROSIVE"). To increase the trip level, tap the top half of the 2nd or 3rd harmonic indicator. To decrease the trip level, tap the bottom half of the 2nd or 3rd harmonic indicator. The trip level can be adjusted from 0% to 50% in 5% intervals.

Mute - Tap this icon to mute the audio. The appearance of the icon will change to indicate that the audio has been muted. Tap the icon again to unmute the audio.

Adjust Volume - Tap this icon to adjust the volume level. After tapping, the Adjust Volume icon will change to Increase Volume and the Mute icon will change to Decrease Volume. The icons will change back to their original state after a few seconds if there is no activity.

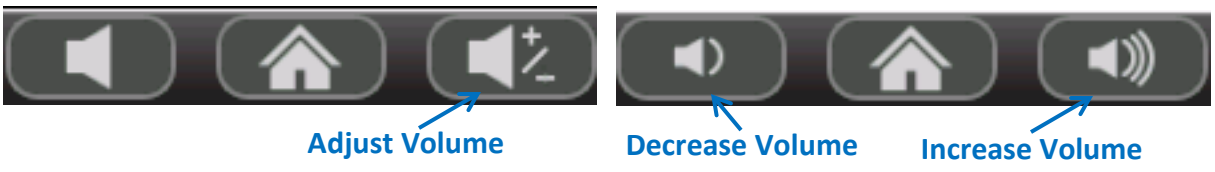
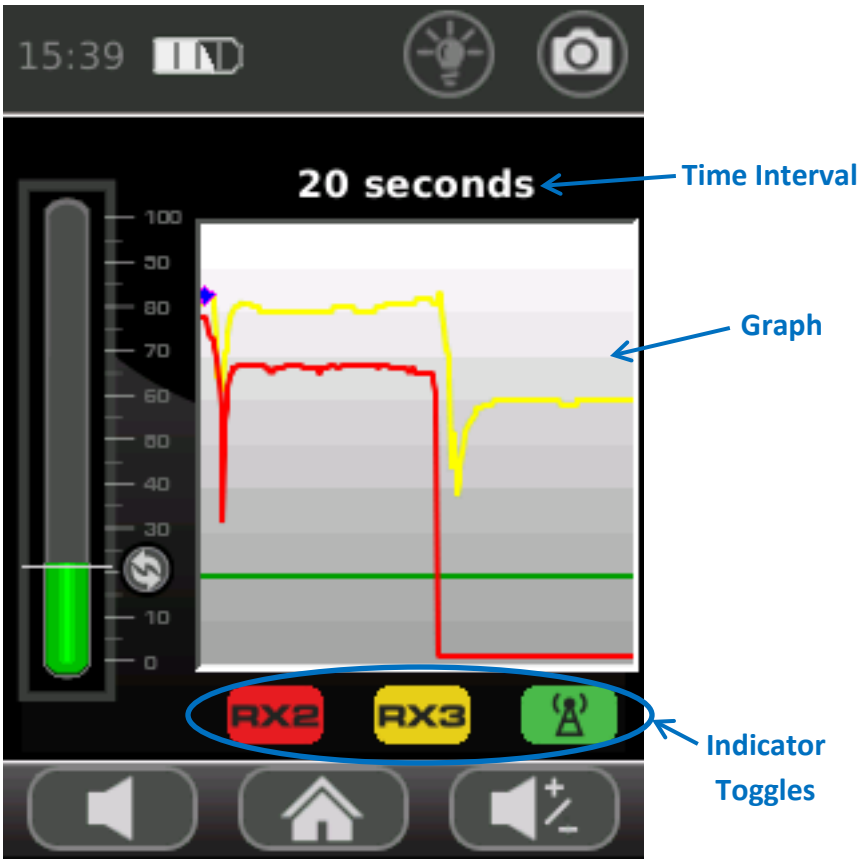


Chart Screen

The chart screen provides a time-based history of the transmit power level, 2nd harmonic level, and 3rd harmonic level.



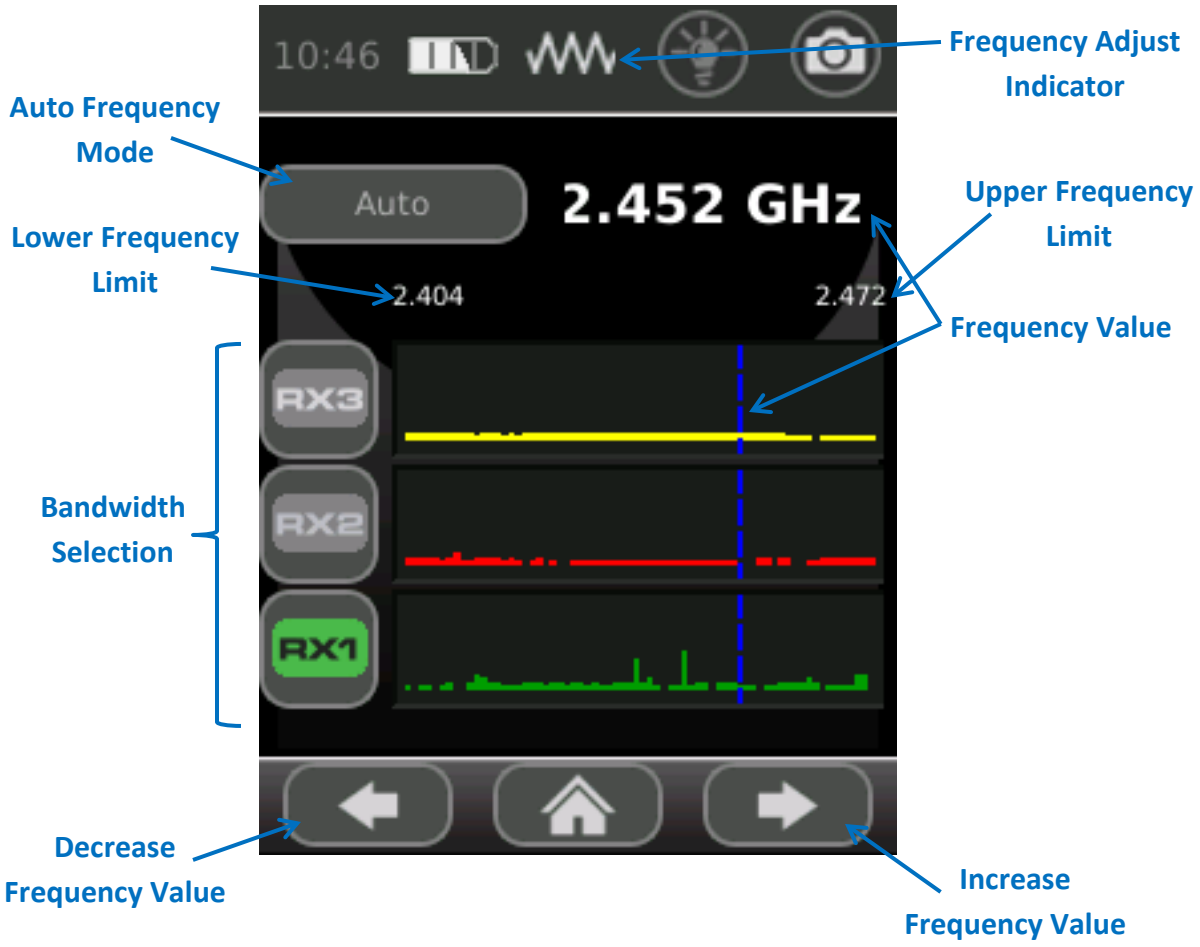
Time Interval - The time interval is the amount of time represented by the horizontal span of the graph. To select a different time interval, tap anywhere on the graph. Selecting a larger time increment will allow more data to be shown on the graph at one time. The range of available values for the time interval is 10s, 20s, 30s, 1m.

Graph - The graph represents a time-based history of the transmit power level, 2nd harmonic level, and 3rd harmonic level. The green trace represents the transmit power level. The red trace represents the 2nd harmonic level. The yellow trace represents the 3rd harmonic level.

Indicator Toggles - The display of the individual traces in the graph can be toggled off or on. To toggle a trace off or on, tap the corresponding indicator toggle. For example, to hide the transmit power level trace in the graph, tap the green indicator toggle. The indicator toggle will turn grey indicating that the corresponding trace is hidden. To display the trace, tap the indicator toggle again.

Frequency Adjust Screen

The frequency adjust screen provides a view of the ambient RF environment allowing the user to select a quiet channel for the transmit frequency.



Frequency Adjust Indicator - The waveform symbol indicates that the ORION is in frequency adjust mode. The transmit power level is turned off in frequency adjust mode.

Auto Frequency Mode - When enabled, the unit will scan the frequency spectrums of the transmitter, 2nd harmonic, and 3rd harmonic to find and select a quiet channel for use, avoiding any interference to and from other devices. If this mode is enabled, the unit will also perform this operation on power up as well.

Frequency Value - This is the value of the transmit frequency. The frequency is represented in numerical form at the top of the screen. A blue dashed cursor also represents the transmit frequency value in the spectrum graph in the middle of the screen. Note: the ORION does not transmit when the unit is in this mode so that it can monitor the ambient RF environment, but this value represents what the transmit frequency will be when this screen is exited and the unit is operating. The frequency value

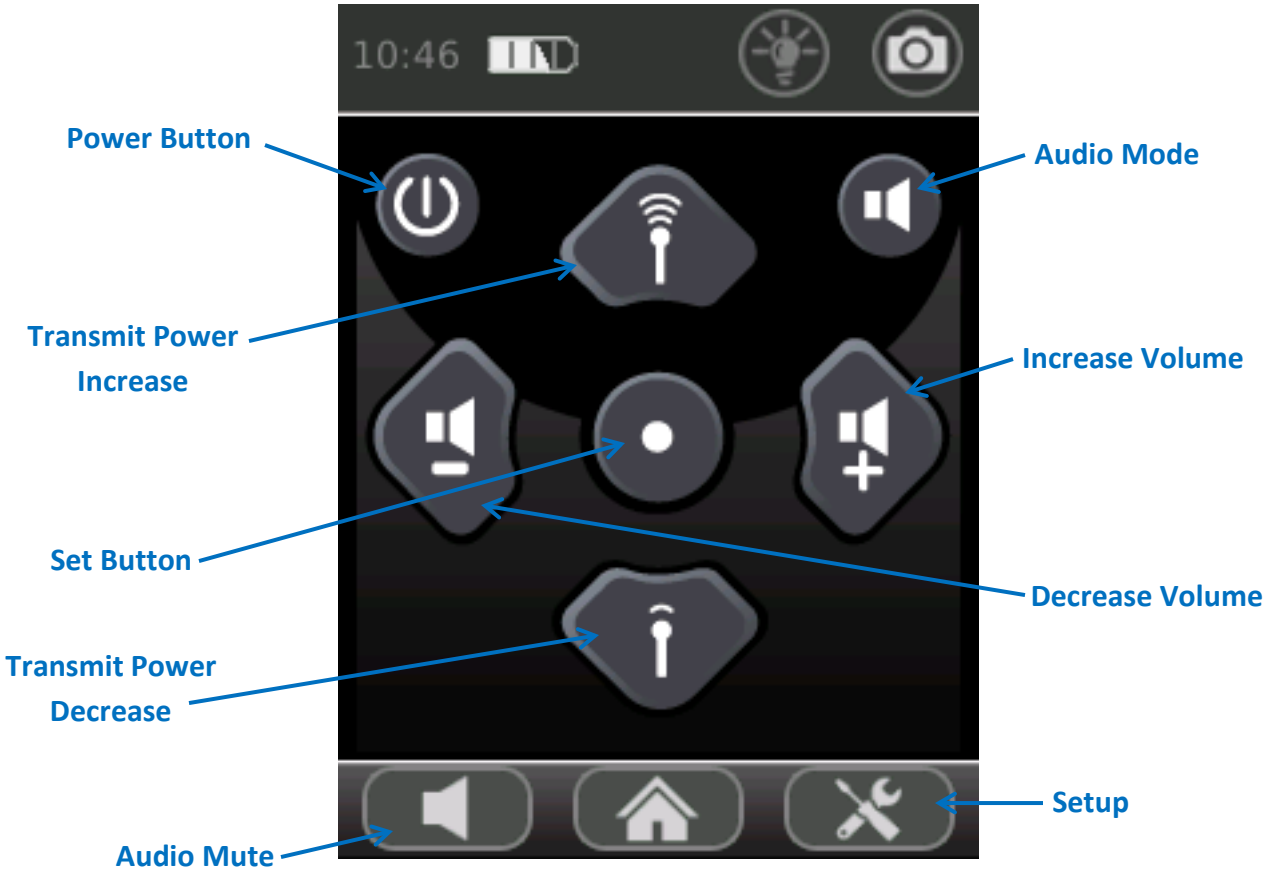
can be adjusted in several ways. The frequency value can be automatically determined by tapping the Auto Frequency Mode button. It can be manually selected by clicking within the ambient RF graphs. Fine adjustment can be done by tapping the "Decrease Frequency Value" or "Increase Frequency Value" buttons at the bottom of the screen.

Bandwidth Selection - The RF graphs in the center of the screen display the ambient RF environment. Only one of the graphs can be active at a time. To select which graph is active, tap the corresponding icon on the left side of the screen. Monitoring the RF environment allows you to select a quiet frequency that avoids interference from other RF sources, such as Wi-Fi or Bluetooth.

Frequency Limits - The Upper and Lower Frequency Limits show the range of the currently selected bandwidth. The value displayed is in GHz.

Keypad Screen

The keypad screen allows alternate methods for making adjustments to the ORION unit. While on the keypad screen, you must monitor the OLED screen on the head of the ORION for feedback.



Power Button - Press and hold this button to turn off the ORION unit. Use the physical power button located above the touch screen to power the unit back on.

Audio Mode - The audio mode button cycles through the various audio modes: Tone, Listen 2nd AM, Listen 2nd FM, Listen 3rd AM, Listen 3rd FM. The selected audio mode will be displayed on the OLED screen located on the head of the ORION. Press and hold this button to mute/unmute the audio.

Transmit Power Increase/Decrease -Adjusts Auto Transmit Power maximum or Manual Transmit Power level depending on current Transmit Power mode (Auto or Manual).

Increase/Decrease Volume - Adjusts the volume level.

Set Button - Tap this button and the OLED screen will display a frequency adjust menu. Use the volume adjustment keys to change the transmit frequency value. Tap the set button again to exit this mode. Press and hold this button to turn on or off the flashlight.

Setup

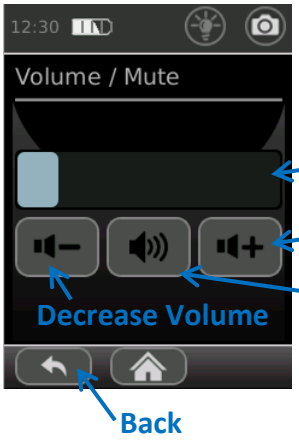
The ORION unit can be configured for multiple situations. The majority of settings changes are handled through the setup screens.

To scroll through the three different setup screens, use the arrow keys at the bottom of the screen.

To make adjustments to one of the setup items, tap the corresponding button.

Note: The Country setting, which is shown on the third setup screen, is only available for model ORION 2.4 HX 3.3W. It is not accessible for model ORION 2.4 HX 6.6W.

Volume



The volume adjustment allows you to control the volume level of the audio cues that are heard through the provided speaker on the unit or through headphones.

Press BACK to return to the setup screen menu after making adjustments.

Audio Mode

The audio mode menu provides configurations for the audible response of the ORION.

Type

Tone - In this mode, synthetic tones will be used to indicate when the 2nd or 3rd harmonic level has exceeded the trip level. The tone style can be configured using the setup menu (see page 25). The trip level can be adjusted on the Bar Graph Screen (see page 17).

RX2 - AM - The received 2nd harmonic signal is AM demodulated and output through the speakers or headphones.

RX2 - FM - The received 2nd harmonic signal is FM demodulated and output through the speakers or headphones.

RX3 - AM - The received 3rd harmonic signal is AM demodulated and output through the speakers or headphones.

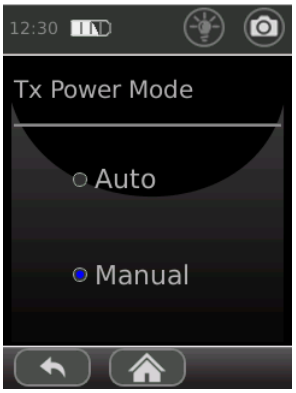
RX3 - FM - The received 3rd harmonic signal is FM demodulated and output through the speakers or headphones.

Source

HP Only - This setting shuts the speaker on the ORION off and audio cues are heard through the headphones only. In this configuration, the speaker will remain OFF regardless of whether headphones are plugged in or not.

Speaker/HP - This setting allows operation of the ORION with either the headphones or the built-in speaker. When no headphones are connected, audio will be heard from the built-in speaker. When headphones are connected, the built-in speaker will automatically shut off and audio will be heard through the connected headphones.

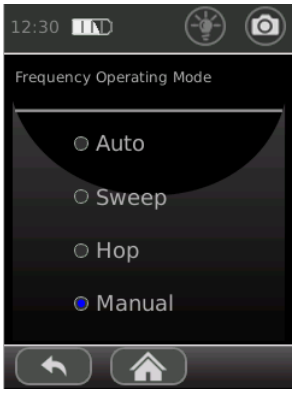
Tx Power Mode



Auto - In auto transmit power mode, the transmit power will automatically reduce whenever the receiver becomes saturated. In auto transmit mode, the set transmit power level is indicated by the Auto Power Level Indicator on the Bar Graph Screen (see page 17) and on the Chart Screen (see page 19). On the head display, the set transmit power level is indicated by a blinking LED in the Tx Power bar graph.

Manual - In manual transmit power mode, the transmit power remains at the same level unless it is manually changed.

Freq Mode



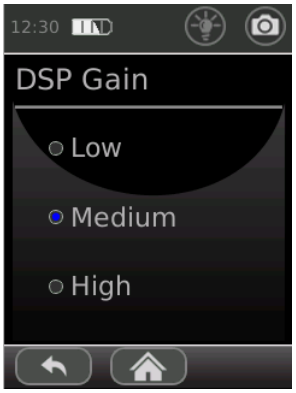
Auto - In auto frequency mode, each time that the unit is powered up, it will scan the frequency spectrums of the transmitter, 2nd harmonic, and 3rd harmonic to find and select a quiet channel for use, avoiding any interference to and from other devices. An auto frequency scan can be initiated at any time from the Frequency Adjust Screen (see page 20).

Sweep - In Sweep frequency mode, the ORION will continuously change the transmit frequency, sweeping through each channel of its range from 2.404 GHz to 2.472 GHz.

Hop - In Hop frequency mode, the ORION will continuously change the transmit frequency, randomly selecting channels throughout its range from 2.404 GHz to 2.472 GHz.

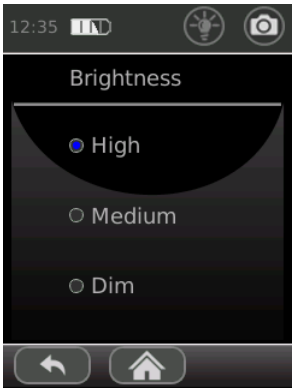
Manual - In manual frequency mode, the transmit frequency will not change unless manually changed. The transmit frequency can be changed from the Frequency Adjust Screen (see page 20).

DSP Gain Level



This setting configures the level of digital signal processing integration that is used to process the received signals. Sensitivity increases as the DSP Gain is increased from Low to High.

Brightness



This setting adjusts the brightness of the OLED screen and the LED Bar Graphs on the head display and the Touch Screen display. There are three available brightness settings: Dim, Medium, High.

Tone Style

Four different styles are available for the Tone Alerts. Note: In addition to setting the Tone Style, the Audio Type from the Audio Mode Menu (see page 23) must be set to "Tone" and the volume must be up to hear the alert tone.

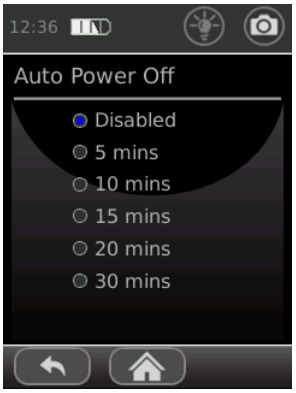
2nd Only - With this Tone Style, an audible, synthetic tone is heard only when the received 2nd harmonic signal level surpasses the set trip level. As the 2nd harmonic signal level increases, the frequency of the synthetic tone will increase.

3rd Only - With this Tone Style, an audible, synthetic tone is heard only when the received 3rd harmonic signal level surpasses the set trip level. As the 3rd harmonic signal level increases, the frequency of the synthetic tone will increase.

2nd/3rd Same - With this tone style, an audible, synthetic tone is heard whenever the received 2nd harmonic signal or 3rd harmonic signal level surpasses the set trip level. As the signal level increases, the frequency of the synthetic tone will increase.

2nd/3rd Diff - With this tone style, an audible, synthetic tone is heard whenever the received 2nd harmonic signal level surpasses the trip level. As the 2nd harmonic signal level increases, the frequency of the synthetic tone will increase. If the received 3rd harmonic signal level becomes higher than the received 2nd harmonic signal level, a lower frequency tone representing the 3rd harmonic will be heard alternating (or warbling) with the 2nd harmonic tone.

Auto Power Off

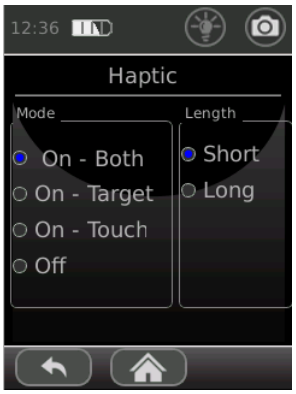


This feature will automatically shut off the unit after a predetermined period of inactivity. A power up operation (pressing the power button) is required to return to full operation.

To enable this feature, select one of the time durations listed to determine how long the unit must be inactive before shutting off. The available durations are: 5, 10, 15, 20, & 30 minutes.

To disable this feature, select "Disabled".

Haptic Style



In addition to visual and audio cues, the ORION will also provide haptic (vibrator) cues whenever the 2nd or 3rd harmonic levels exceed the trip levels. The trip level can be adjusted on the Bar Graph Screen (see page 17).

Mode

On - Both - with this setting, the unit will vibrate whenever the 2nd or 3rd harmonic levels exceed the set trip level or whenever the user interacts with the touch screen.

On - Target - with this setting, the unit will only vibrate whenever the 2nd or 3rd harmonic levels exceed the set trip level.

On - Touch - with this setting, the unit will only vibrate whenever the user interacts with the touch screen.

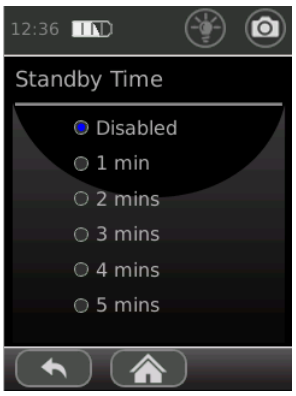
Off - with this setting, the unit will not provide any haptic feedback.

Length

Short - vibration feedback will be set to short pulses.

Long - vibration feedback will be set to longer pulses.

Standby Time

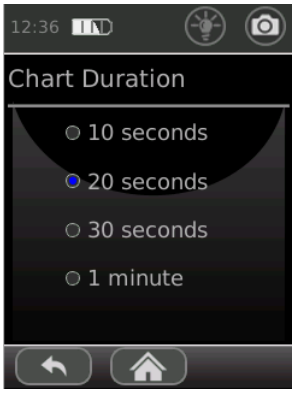


This menu configures Standby Mode. This feature will automatically put the unit into a low power state after a predetermined period of inactivity. Full operation returns when the unit is picked up or handled.

To enable this feature, select one of the time durations listed to determine how long the unit must be inactive before going into Standby Mode. The available durations are: 1, 2, 3, 4, & 5 minutes.

To disable this feature, select "Disabled".

Chart Duration

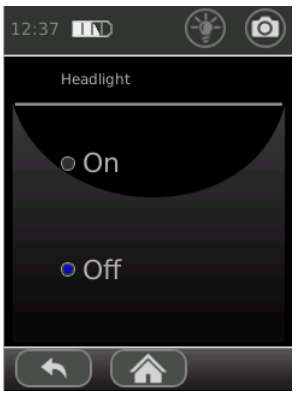


This menu configures the displayed duration of the chart on the chart screen.

The available ranges for chart duration are: 10 seconds, 20 seconds, 30 seconds, & 1 minute.

Chart duration can also be configured from the Chart Screen (see page 19).

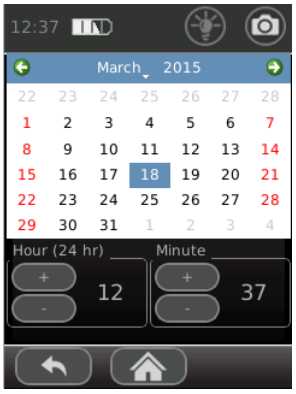
Headlight



This menu toggles the headlight on and off.

The headlight can also be toggled on/off from the headlight control that appears in the status bar of each screen (see Page 16)

Date/Time

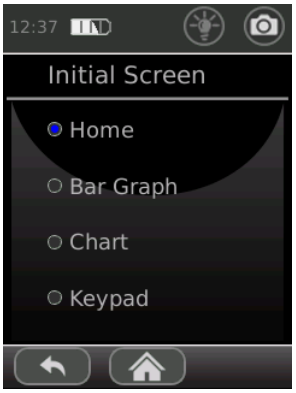


This menu is for setting the current date and time.

The time is displayed in the status bar of each screen.

The date and time is also displayed on any screen captures that are saved with the ORION.

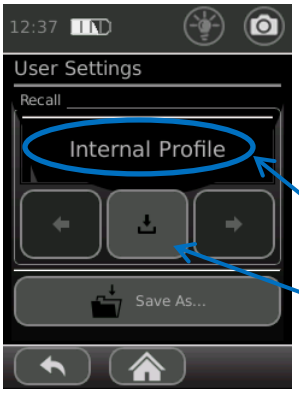
Initial Screen



This menu configures which screen is shown first whenever the unit is powered up.

There are four available choices for initial screen: Home, Bar Graph, Chart, & Keypad.

User Settings



After setting up the configurable items on the ORION (Audio Mode, Tx Power Mode, Freq Mode, Brightness, Tone Style, etc…), the unit is able to save this configuration for recall at a later time. Using a micro SD storage device, up to 7 different configurations can be saved.

Saved Profile List

Load Settings Button

Any saved configurations *or* profiles show up in the Saved Profile List. To scroll through the saved profiles in the list, tap the left or right arrows on the screen. Once the name of the saved profile is

displayed on the screen, press the Load Settings button to load those settings to the ORION. If SD Card profiles have been saved to a micro SD card, then that specific micro SD card must be inserted in the ORION to recall those profiles.

To save the current configuration, press the "Save As…" button. From the dialog box that appears, select one of the listed profiles. Select "OK". Note: If the selected profile already has a saved configuration, that configuration will be overwritten with the new configuration. The SD Card profiles are only available if a Micro SD card is inserted in the unit.

Country

This setting is only available for the ORION 2.4 HX 3.3W model.

The ORION 2.4 HX 3.3W is CE Marked but some countries in the EU restrict the use of the ORION 2.4. To operate the ORION 2.4 legally, it must be operated within these restrictions for the given country. The "Country" setting allows the user to configure the ORION 2.4 for operation within the restrictions imposed by these countries. The table below lists these restrictions by country and the proper setting for the ORION unit when operated within these countries.

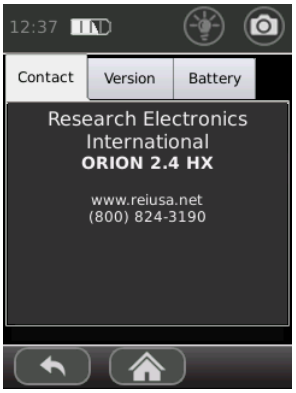
NOTE: The model ORION 2.4 HX 6.6W is not CE Marked and the Country menu is not accessible for this model.

Country	Restrictions	"Country" setting for ORION 2.4 HX 3.3W
Austria (AT)	100 mW Max Transmit Power	Austria
Belgium (BE)	No restrictions	FCC/IC/CE
Bulgaria (BG)	2.446 GHz to 2.454 GHz Transmit Freq Range	Bulgaria
Cyprus (CY)	No restrictions	FCC/IC/CE
Czech Republic (CZ)	No restrictions	FCC/IC/CE
Denmark (DK)	No restrictions	FCC/IC/CE
Estonia (EE)	No restrictions	FCC/IC/CE
Finland (FI)	No restrictions	FCC/IC/CE
France (FR)	10 mW Max Transmit Power	France
Germany (DE)	25 mW Max Transmit Power	Germany
Greece (GR)	No restrictions	FCC/IC/CE
Hungary (HU)	10 mW Max Transmit Power	Hungary
Iceland (IS)	No restrictions	FCC/IC/CE
Italy (IT)	10 mW Max Transmit Power	Italy
Ireland (IE)	No restrictions	FCC/IC/CE
Japan	10 mW Max Transmit Power	Japan
Latvia (LV)	No restrictions	FCC/IC/CE
Liechtenstein (LI)	10 mW Max Transmit Power	Liechtenstein
Lithuania (LT)	10 mW Max Transmit Power	Lithuania

Country	Restrictions	"Country" setting for ORION 2.4 HX 3.3W
Luxembourg (LU)	No restrictions	FCC/IC/CE
Malta (MT)	No restrictions	FCC/IC/CE
Netherlands (NL)	No restrictions	FCC/IC/CE
Norway (NO)	No restrictions	FCC/IC/CE
Poland (PL)	No restrictions	FCC/IC/CE
Portugal (PT)	10 mW Max Transmit Power	Portugal
Romania (RO)	No restrictions	FCC/IC/CE
Slovak Republic (SK)	No restrictions	FCC/IC/CE
Slovenia (SI)	10 mW Max Transmit Power	Slovenia
Spain (ES)	No restrictions	FCC/IC/CE
Sweden (SE)	No restrictions	FCC/IC/CE
Switzerland (CH)	10 mW Max Transmit Power	Switzerland
United Kingdom (UK)	No restrictions	FCC/IC/CE

* Note: The operator violates German law if the unit is operated with a higher power than permitted. Fine regulation of TKG §148 and §149 could apply. Units shipped into Germany will be preset with the German Country setting.

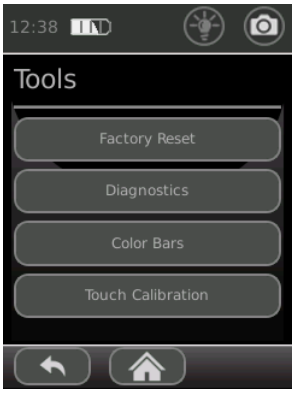
Info



This menu displays general information about REI, software versions, and battery status.

To access the information included, select the tabs across the top of the screen.

Tools



This menu contains additional tools for the ORION 2.4 HX.

Factory Reset - Original factory user settings can be restored to the unit using the Factory Reset button.

Diagnostics - Performs diagnostic communication tests and displays the results.

Color Bars - Displays a set of Color Bars for Touch Screen display evaluation.

Touch Calibration - In order to properly align the touch screen to the display,

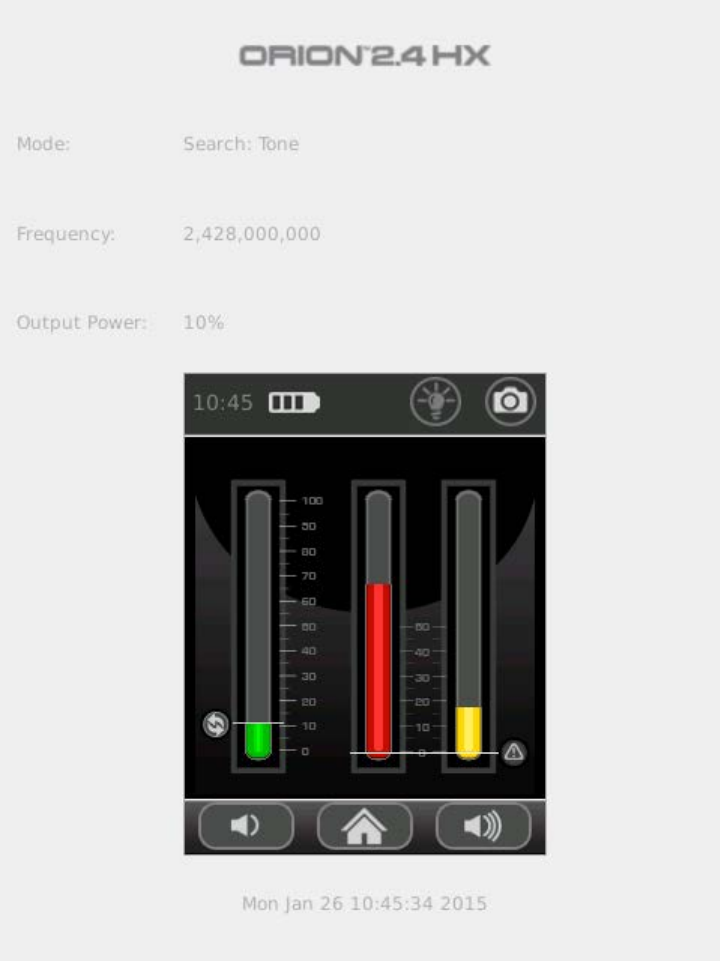
it may be necessary to calibrate the touch screen. After selecting the Touch Calibration button, follow the on-screen instructions.

Additional Features

Screenshot

To assist in report-writing, the ORION provides the ability to capture screenshots from the display. Screenshots are stored as PNG files and are saved to an inserted micro SD card. To use this function, insert a micro SD card into the micro SD card slot near the top of the touch screen display. Then tap the screenshot icon that appears in the status bar on any screen. If successful, the message "Save Complete" will briefly appear in the status bar area.

In addition to the captured screenshot, the saved image file also has additional information such as the date/time, mode, frequency, & power level.



Specifications

TRANSMITTER

Frequency Bands: 2.404 GHz – 2.472 GHz center
Transmit Channels: Manual or Auto selection, more than 60 available
Maximum Transmit Power (ORION 2.4 HX 6.6W): 6.6 W EIRP
Maximum Transmit Power (ORION 2.4 HX 3.3W): 3.3 W EIRP
Power Control: Manual or Auto control
Detection Modulation: Digital 1.25 MHz BW

RECEIVER

Simultaneous 2nd & 3rd harmonic receive
Digitally Correlated
Frequency Bands: Transmit Band (2.404 GHz – 2.472 GHz); Second Harmonic (4.808 GHz – 4.944 GHz); Third Harmonic (7.212 GHz – 7.416 GHz)
Sensitivity: -140 dBm for both harmonics

DISPLAY

Handle Mounted Touch Screen Controller Display
Antenna-Mounted Display
Bar Graph Display for transmit power level, 2nd harmonic level, 3rd harmonic level, data field display, for other information (operation mode, low battery, volume, DSP gain, etc.)

MECHANICAL

Extension Lengths: 16-51 in (40.6 - 129.5 cm)
Case Dimensions: 6.25 in x 14.9 in x 18.5 in (15.9 cm x 37.8 cm x 47.0 cm)
ORION 2.4 Dim: 22.4 in x 3.75 in x 3 in (57 cm x 9 cm x 7.5 cm)
Overall Extended Length: 58 in (147 cm)
ORION 2.4 Weight w/ Battery: 3 lbs (1.4 kg)
Case Weight including ORION 2.4 HX & Accessories: 12 lbs (5.4 kg)

MAIN BATTERY

Input AC: 100 - 240 V, 50 – 60 Hz
Run Time: >4 hours per battery (typical)
Charge Time: 2.5 hours per battery (typical)
Batteries: Lithium Ion Rechargeable Battery (2 included)
The supplied battery pack: RRC Power Solutions Lithium Ion Rechargeable Battery pack Model #RRC2040, rated 11.25V, 2950mAh, 33.2Wh *or* Inspired Energy Lithium Ion Rechargeable Battery pack Model #NC2040HD, rated 10.8V, 2.9Ah, 31Wh.

THERMAL

Operating Temperature: -10 to 50°C
Battery Charging Temperature: 5 to 37°C
Storage Temperature: -20 to 60°C
Note: extended storage at temperatures above 40°C could degrade battery & OLED display performance and life.

CE

ORION 2.4 HX 3.3W is CE Marked
ORION 2.4 HX 6.6W is not CE Marked

Product specifications and descriptions subject to change without notice

APPENDIX

The ORION 2.4, designed and built by the engineers at Research Electronics International, is the latest advancement in Non-Linear Junction Evaluation. The ORION 2.4 can be used to locate electronic devices whether in furniture, walls, ceiling fixtures or elsewhere. The ORION 2.4 detects semiconductor junctions, to alert in the presence of electronics.

It is important to note that due to the variations in electronic circuitry, the unit will respond differently to different electronic circuits. Therefore, the manufacturer makes no guarantee about the performance of the unit when attempting to detect hidden electronic devices.

Background Theory

The ORION 2.4 radiates RF energy at frequency f_0 and receives energy at $2f_0$ & $3f_0$. When the radiated signal at f_0 encounters a non-linear junction, some of the energy is re-radiated back at $f_0, 2f_0, 3f_0, \ldots$ It is the non-linear characteristic of the junction that generates $2f_0, 3f_0, \ldots$ (the 2nd & 3rd harmonics respectively). By observing the presence of returned signals at $2f_0$, $3f_0$, the user can detect the presence of a non-linear junction.

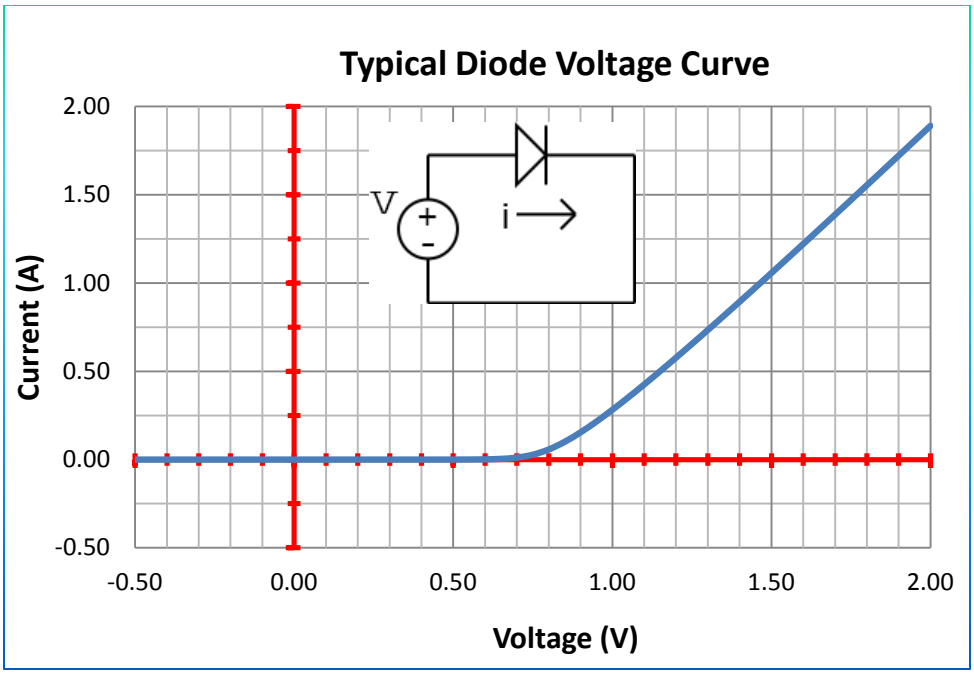
Now consider a basic diode; the simplest form of an electronic non-linear junction.

$$i = I_s \left[e^{qv/kT} - 1 \right]$$

Eq. 1

Where i is the current of the signal, I_s the leakage current, q equals the electron charge, v is the voltage, K equals Boltzman's constant, and T is the temperature in Kelvins.

A plot of this equation for a typical diode looks something like the following:



If we approximate Eq. 1 near the origin using Taylor Series,

$$i = I_s \left[\frac{vq}{kT} + \frac{\left(\frac{vq}{kT}\right)^2}{2} + \frac{\left(\frac{vq}{kT}\right)^3}{6} + \ldots \right] \qquad \text{Eq. 2}$$

For small signals across the diodes terminals, we can reduce this to the first three terms,

$$i \sim I_s \left[\frac{vq}{kT} + \frac{\left(\frac{vq}{kT}\right)^2}{2} + \frac{\left(\frac{vq}{kT}\right)^3}{6} \right] \qquad \text{Eq. 3}$$

In Eq. 3, the second term is responsible for generating the 2nd harmonic and the third term is responsible for generating the 3rd harmonic.

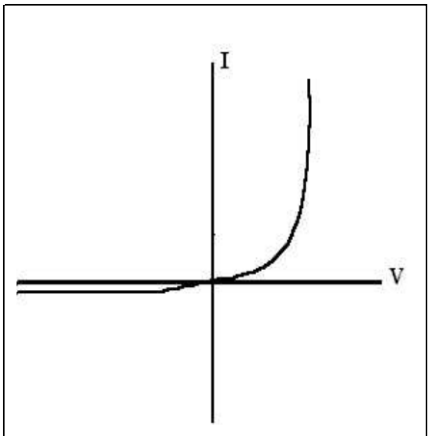
Electronic devices typically have many different non-linear junctions (diodes, transistors, etc.) linked by wires or printed circuit board traces. Therefore energy can be radiated in and out of the device through complex paths. Typically the 2nd harmonic signal is stronger than the 3rd harmonic signal. However, some circuits can re-radiate strong 3rd harmonic signals.

Other situations can also produce harmonic signals. Two dissimilar metals, joined or touching, and corroded metals return harmonic signals (passive intermodulation). These we will refer to as false junctions (Sometimes called “rusty bolt effect” or “environmental diodes”.)

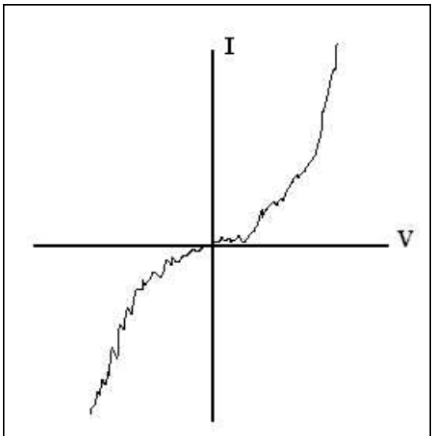
The junctions in electronic devices and those in false junctions are quite different. The junctions in electronic devices are well defined, but those created by false junctions are not as well defined or as clean a physical junction. Imagine two perfect cubes joined—this would be a junction found in electronic devices. False junctions are more like two irregularly shaped items touching in places, but not in a smooth, regular pattern.

http://en.wikipedia.org/wiki/File:Rust_Bolt.JPG

Although there are various different types of semiconductor junctions (PN, PIN, JFET, MOSFET, etc.), they all produce clean, predictable junction characteristics. For the junctions found in electronic devices, this equation produces a predictable, but unsymmetrical curve. False junctions produce a less regular curve, one that is noisy and unpredictable, yet they are typically symmetrical: their curve is mirrored for negative values. The current/voltage characteristics are illustrated below.



Semiconductor Junction Characteristics



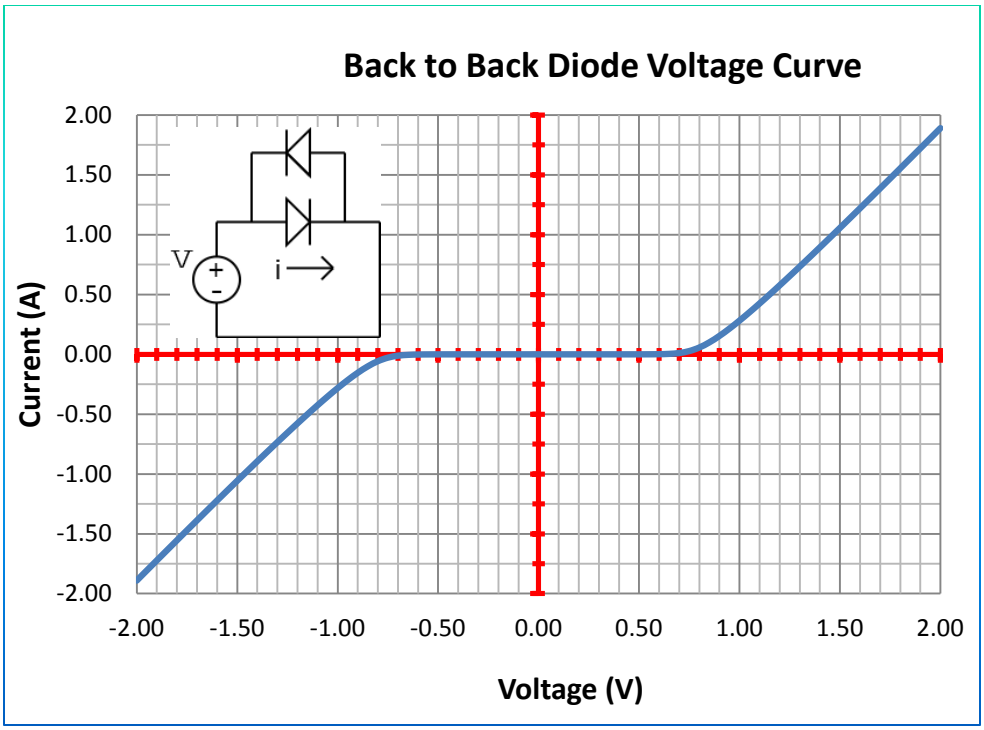
False Junction Characteristics

This level of regularity in the junction results in differences in the harmonic signals. When the ORION 2.4 radiates a signal that is returned by the junction in electronics, it results in a strong 2nd harmonic signal and a weak 3rd harmonic. A false junction returns a very weak 2nd harmonic and a strong 3rd.

A **B**

ORION 2.4 COMPARISON OF HARMONIC LEVELS
(A – Semiconductor, B – False Junction; Bar graphs on the right are the 2nd and 3rd harmonic levels)

As mentioned earlier, some semiconductor circuits re-radiate a strong third harmonic signal. For example with two diodes connected back to back (see below), the shape of the voltage curve resembles the symmetry of a false junction and produces a stronger third harmonic than does a single diode.


Back to Back Diode Voltage Curve
Current (A)
Voltage (V)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.00
-1.50
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
V
+
-
i

APPENDIX

The ORION2.4 HX software is © Research Electronics International 2015. It is licensed under the LGPL license.

Qt License

The ORION2.4 HX software dynamically links to unmodified Nokia Qt4 Library. The Qt4 Library is © 2011 Nokia Corporation and/or its subsidiary(-ies), and is licensed under the GNU Lesser General Public License version 2.1 with Nokia Qt LGPL exception version 1.1.

Qt4 library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License, version 2.1, as published by the Free Software Foundation.

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(i) the header files of the Library have not been modified; and
(ii) the incorporated material is limited to numerical parameters, data structure layouts, accessors, macros, inline functions and templates; and
(iii) you comply with the terms of Section 6 of the GNU Lesser General Public License version 2.1.

Moreover, you may apply this exception to a modified version of the Library, provided that such modification does not involve copying material from the Library into the modified Library's header files unless such material is limited to (i) numerical parameters; (ii) data structure layouts; (iii) accessors; and (iv) small macros, templates and inline functions of five lines or less in length.

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ORION 2.4 HX is based in part on the work of Qt 4.8.

The source code for Qt 4.8 SDK is available from Nokia here: http://download.qt.io/archive/qt/4.8/4.8.0/qt-everywhere-opensource-src-4.8.0.zip
It is also available on request from Research Electronics International.

Qwt License

Version 1.0, January 1, 2003

The Qwt library and included programs are provided under the terms

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exceptions:

1. Widgets that are subclassed from Qwt widgets do not constitute a derivative work.

2. Static linking of applications and widgets to the Qwt library does not constitute a derivative work

and does not require the author to provide source code for the application or widget, use the shared

Qwt libraries, or link their applications or widgets against a user-supplied version of Qwt.

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ORION 2.4 HX is based in part on the work of the Qwt project (http://qwt.sf.net).

GNU Lesser General Public License

Version 2.1, February 1999

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END OF TERMS AND CONDITIONS

CE DECLARATION OF CONFORMITY

Manufacturer's Name: **Research Electronics International (REI)**
Manufacturer's Address: 455 Security Drive, Algood, TN 38506 USA
Equipment Description: Non-Linear Junction Detector
Equipment Model Designation: ORION 2.4, ORION 2.4 HX 3.3W

Referenced Directives:
LVD (Low Voltage) Directive 2006/95/EC
EMC (Electromagnetic Compatibility) Directive 2004/108/EC

Referenced Standards:
LVD Standards: EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013
EMC Standards: EN 301 489-3 V1.6.1 (2013-08), EN 55022:2010 + AC:2011, Class B, EN 61000-3-2:2014, EN 61000-3-3:2013, EN 55024:2010

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